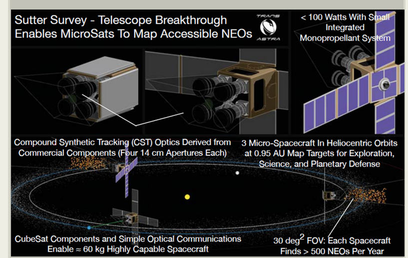
NASA Innovative Advanced Concepts

Sutter: Breakthrough Telescope Innovation for Asteroid Survey Missions to Start a Gold Rush in Space

Completed Technology Project (2017 - 2018)

Project Introduction

PROBLEM: These are three primary reasons why it is important for NASA to develop better ways to locate and characterize Near Earth Objects (NEOs). First, NEOs are an impact hazard to the Earth and Congress has mandated that NASA find 90% of all the objects over 140 meters by the end of 2020. NASA will fail to meet this mandate because of the high cost of current asteroid survey approaches. Second, measuring the NEO population distributions in space will unlock the answers to critical questions dealing with the formation and evolution of the solar system. Finally, NEOs are exciting candidates as targets for human exploration and they represent a virtually unlimited resource of valuable material for radiation shielding, propellant, and life support consumables that could make NASA's envisioned deep space human exploration program affordable. Current models suggest that for every > 140 m NEO, such as those targeted by the Congressional mandate, there are about twenty intermediate sized (>40 meter class) objects. Intermediate sized objects are more likely to impact the Earth with detrimental effect but are not efficiently identified by current survey methods. One such example was the Chelyabinsk meteor which hit Russia in 2013 damaging 7,000 buildings and injuring 1,491 people. Going further down the size scale, for each 140 m object there are over >1,000 ten meter objects and more than >8,000 five meter objects. Due to their large numbers, these smallest of NEOs are the most likely to be highly accessible as space resource and human exploration targets, and because their size makes them easier to capture and work with using reasonably sized equipment, they are ideally suited as sources of ISRU space resources. Unfortunately, no sky surveys or methods currently being conducted or planned can find a significant fraction of these most plentiful and valuable but elusive small volatile rich targets. Sutter changes all that. CONCEPT: To solve this critical unmet need we envision a new type of low cost, high performance compound telescope, the Compound Synthetic Tracker (CST) which we propose for a series of new space missions that takes advantage of recent advances in electronics, CubeSat technology, laser communications, and off-the-shelf optics for camera zoom lenses. The first space mission concept we propose based on CST is the Sutter Survey, named after the Sutter's Mill discovery which led to the California gold rush. The Sutter Survey project can lead to a gold rush in space to exploit the resources of the small highly accessible NEOs that we intend to find and characterize. As depicted in the summary chart, our concept involves a constellation of three CubeSat scale spacecraft in heliocentric space each 120 degrees apart in the plane of the ecliptic with a semi-major axis of about 0.95 AU. We estimate that this entire constellation can be built for less than $50M, launched as piggy back payloads, and perform like the billion dollar, 8 m aperture Large Synoptic Survey Telescope (LSST) ground based telescope at finding and tracking small dark asteroids. Beyond Sutter Survey is Sutter Extreme, a New Horizons class mission that performs beyond the flagship level to increase the discovery rate of dangerous impactors by more than 24X and find and characterize more than 7,500 new NEOs every year.



Sutter: Breakthrough Telescope Innovation for Asteroid Survey Missions to Start a Gold Rush in Space Credits: Joel Sercel

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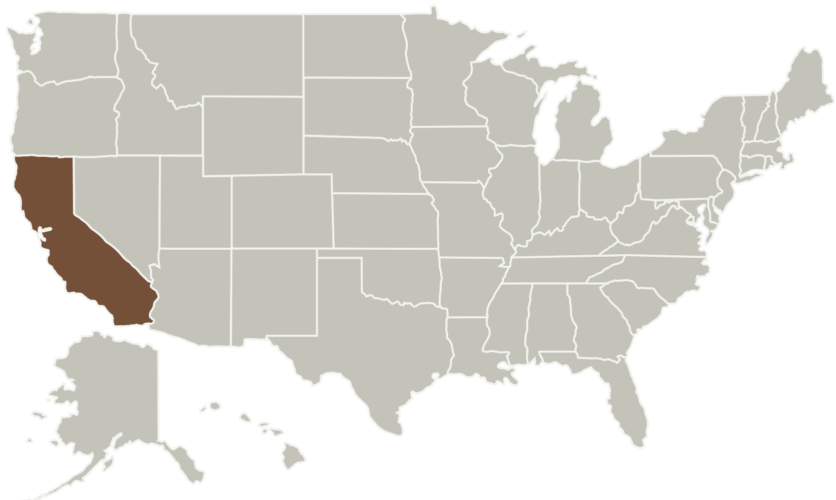
Anticipated Benefits

The Sutter Survey project can lead to a gold rush in space to exploit the resources of the small highly accessible NEOs that we intend to find and characterize.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Trans Astronautica Corporation	Lead Organization	Industry Small Disadvantaged Business (SDB)	Houston, Texas

Primary U.S. Work Locations
California

Project Transitions

April 2017: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Trans Astronautica Corporation

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

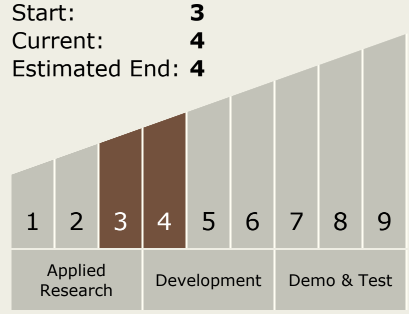
Eric A Eberly

Principal Investigator:

Joel Sercel

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



January 2018: Closed out

Closeout Summary: There are three primary reasons why it is important for NASA to develop better ways to locate and characterize Near Earth Objects (NEOs). First, NEOs are an impact hazard to the Earth and congress has mandated that NASA find 90 percent of all the Potentially Hazardous Objects (PHOs) over 140 meters by the end of 2020. NASA will fail to meet this mandate due to funding limitations and the cost and technical performance of current asteroid survey approaches. The Sutter Survey will solve this problem. Second, measuring NEO population distributions will unlock the answers to critical questions dealing with the formation and evolution of the solar system. Finally, NEOs are important targets for human exploration and they represent a virtually unlimited long term resource of valuable material for radiation shielding, propellant, and life support consumables that could make NASA's planned deep space human exploration program affordable. In the past few years it has become increasingly clear that space exploration, commercialization, and colonization are not affordable as long as they are dependent on Earth for all of the resources involved. Even with the recent advances in launch vehicle cost reductions, the requirements for material (and particularly propellant) from Earth rapidly makes any ambitious program unrealistic, given the costs involved. However, lunar or asteroid resource extraction and utilization have the potential to radically reduce the need for large quantities of propellant and other resources from Earth, and to do so in a manner that makes economic and commercial sense as well. Before asteroid In-Situ Resource Utilization (ISRU) can become a reality, the technology to find and track useful asteroids must be developed. Current Earth-based telescopes are not designed for this purpose and are limited by atmospheric considerations. Most asteroid detection efforts have been relegated to finding potentially hazardous object (PHOs) which, while important for the long term survival of humanity, is not suitable for finding targets for asteroid ISRU. For every >140 m NEO, such as those targeted by the congressional mandate, there are about 200 intermediate sized (≈>20 meter class) objects. Going further down the size scale, for each 140 m object there are estimated to be over 1,000 ten meter sized objects and more than 8,000 objects five meters or larger. Due to their large numbers, these smallest of NEOs are the most likely to be highly accessible as space resource and human exploration targets. Because their size makes them easier to capture and work with using reasonably sized equipment, they are ideally suited as sources of ISRU space resources. Unfortunately, no sky surveys or methods currently being conducted or planned can find a significant fraction of these most plentiful and valuable but elusive small volatile rich targets. The energy requirements for accessing these NEO asteroids are less than half that required for lunar surface operations, which makes them a more attractive near-term solution, and could pave the way for later lunar surface missions. The Sutter Survey approach applies new information processing capabilities and algorithms, small-satellite technology, and mission design concepts to create a series of affordable space missions that are specifically designed to identify these target asteroids and thus make their use for space resources a reality. This approach consists of an initial ground demonstration to verify the novel tracking software approach by using an existing telescope with an image plane and processing hardware that is similar if not identical to that planned for the following flight demonstration. The ground demonstration is then followed by a cube-sat implementation for an Earth orbiting mission to further refine the approach and provide additional evidence of intended performance. The full Sutter Survey mission, consisting of 3 small spacecraft, would then be launched into a novel heliocentric pseudo-Earth orbit that would keep the spacecraft with ~0.05 AU (approximately 7.5 million kilometers) of Earth and allow for iden

Technology Areas

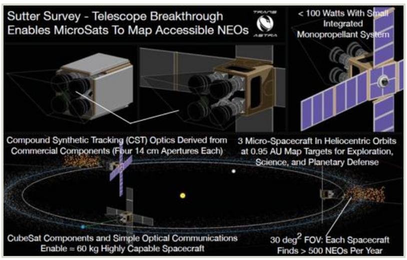
Primary:

- TX07 Exploration Destination Systems
  - └─ TX07.1 In-Situ Resource Utilization
    - └─ TX07.1.1 Destination Reconnaissance and Resource Assessment

Target Destination

Others Inside the Solar System

Images



Project Image
Sutter: Breakthrough Telescope Innovation for Asteroid Survey Missions to Start a Gold Rush in Space Credits: Joel Sercel
(https://techport.nasa.gov/image/102150)

Links

NASA.gov Feature Article
(https://www.nasa.gov/directorates/spacetech/niac/2017_Phase_I_Phase_II/Gold_Rush_in_Space)